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Studying Soil Trends Linked To Increased Sustainability

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Some irrigated rice fields in Asia are still productive after thousands of years of cultivation. Irrigation in Mediterranean climates, such as California's, has a more problematic history.

Archaeological records from Mesopotamia (now Iraq) reveal a gradual substitution of salt-tolerant barley for salt-sensitive wheat. As salt from irrigation water accumulated in the soil, the soil eventually became too salty even for barley, and the civilization collapsed.

Irrigation-related soil salinity already affects crop yields in some parts of California's Central Valley. Proper drainage may solve this problem, but salt is not the only possible threat.

DENNIS BRYANT

THE WHEAT-TOMATO ROTATION, ONE OF 10 CROPPING SYSTEMS AT LTRAS, IS TYPICAL OF LOCAL COMMERCIAL PRACTICE.

There is evidence that soil organic matter, which is generally low in hot and dry climates, has decreased even further with cultivation. Changes in other soil properties, such as acidity or soil structure, could also limit the crops that can be grown in California in the future, or their yield or quality.

As an "early warning system" to detect these and other potential threats to their state's agricultural future, researchers at the University of California at Davis launched the Long-Term Research on Agricultural Systems (LTRAS) experiment in 1993. The experiment monitors changes in a variety of cropping systems, including an organic system and systems using cover crops.

Soil quality factors like salinity and organic matter typically change over decades, not years. LTRAS has a planned duration of 100 years. With proper controls, replication, and monitoring methods, trends that might not be obvious on-farm should be detected early enough to identify and implement solutions before the damage is irreversible.

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Funding from the USDA's National Research Initiative (NRI) Competitive Grants Program supported a team effort to collect the baseline data needed to identify these long-term trends. The full significance of this work will probably not be known for some years, but some short-term trends are clear.

Short-Term Trends

Cropping systems at LTRAS include winter legume cover crops. Through their symbiosis with beneficial bacteria that colonize their roots, these "green manure" crops contribute significant amounts of nitrogen (N) to following crops, thereby reducing or eliminating the need for N fertilizer.

Research showed, however, that the timing of N release from decomposing cover crop is not always optimal, either for crop yield or the environment.

One year, a large fraction of the N was lost, due to unusually heavy rain prior to the following wheat crop. Synthetic N fertilizer suffered a similar fate.

Corn yields were consistently lower after a winter legume cover crop, relative to systems using N fertilizer, because of planting delays required for sufficient cover crop growth.

Cover crops appear to have other benefits unrelated to N. Infiltration of water into the soil improved in systems with cover crops. This actually increased water requirements in the organic system, relative to its closest conventional counterpart. But, in wet years, systems with cover crops had significantly higher tomato yield.

The researchers also made significant progress in understanding how soil microorganisms affect soil fertility in response to wetting and drying during irrigation, and in the use of computer models in managing these complex interactions.

Impact

Reliable predictions of long-term sustainability from yields alone typically require at least 10 years of data. However, the researchers have already seen some apparent trends in soil quality factors that could begin to affect yield.

Analyzing these kinds of trends and their links to system performance is important in determining the range of conditions (soil type, climate, etc.) under which farmers should expect similar results, with the ultimate goal of improving long-term sustainability of irrigation agriculture.

Other researchers on this project include J. Hopmans, L. Jackson, R. Miller, R. Norris, D. Phillips, D. Rains, D. Rolston, and K. Scow. For more about LTRAS, see website http://LTRAS.ucdavis.edu.

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